The Meaning and Use of Feed Analysis

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An animal's nutrient requirements must be met if optimum performance is to be obtained. Thus, the first step in developing a feeding system is to properly identify energy, protein, mineral and vitamin requirements. The next step is to calculate the combination of feeds among those available that will economically meet these requirements,

The nutrients required for growth and/or milk production are compared to nutrients available, and the deficiencies are met by adding feeds containing high concentrations of the deficient nutrients. Therefore, to accurately assess whether a feed will meet the animal's requirements, accurate estimates of the nutrients is necessary, whether the feeds are home grown or purchased.

Nutrient values for individual feeds vary considerably from farm to farm and from year to year, as a result of differences in variety, soil fertility, weather, date of harvest, and harvesting and storage procedures. Table I presents the average, minimum, maximum and standard deviation for several nutrients in selected New York feeds that were analyzed by the Dairy One Forage Lab (http://dairyone.com/). Shown at the top of the table are the requirements for growing calves, finishing cattle and early lactation cows. These values can be compared to those for individual feeds to see which are deficient in various nutrients.

Looking at the standard deviation of the nutrients, it is evident that corn grain is much more consistent than any of the mixed mostly grass forages. As corn grain makes up about 50% of corn silage on a dry matter basis, it lands in between grain and forage relative to consistency. Given that most of the cattle in the northeast are not fed a high grain diet, if producers are to economically meet the nutrient requirements of their herds, then forage analysis is money and time well spent.

Table 1. Nutrient composition of New York feeds from Dairy One Forage Lab, 2016[1]

	DM	CP	RDP	RDP	TDN	Ca	P
	%	%	% CP	%	%	%	%
		Requirement for growing calves[2]					
	-	10.9	-	8.1	62.5	0.40	0.23
		Requirement for finishing cattle[3]					
	-	11.4	-	9.0	70	0.42	0.21
		Requirement for early lactation beef cow[4]					
	-	7.8	-	5.7	53	0.26	0.17
	Composition of feed samples						
FEED							

Mixed mostly grass haylage - June (239 samples)							
Average	40.2	17.6	73.6	12.9	64.1	0.8	0.3
Minimum	28.7	14.4	68.1		58.7	0.6	0.3
Maximum	51.6	20.8	79.2		69.5	1.1	0.4
Standard Deviation	11.5	3.2	5.5		5.4	0.3	0.1
Mixed mostly grass hay - June (27 samples)							
Average	90.0	12.2	68.1	8.3	62.2	0.5	0.3
Minimum	88.7	8.9	64.7		57.5	0.4	0.2
Maximum	91.3	15.5	71.6		66.9	0.7	0.3
Standard Deviation	1.3	3.3	3.5		4.7	0.2	0.1
Mixed mostly grass hay – October (66 samples)							
Average	90.5	12.9	66.6	8.6	61.6	0.7	0.3
Minimum	89.2	9.5	62.2		57.2	0.5	0.2
Maximum	91.7	16.4	71.0		66.0	0.9	0.4
Standard Deviation	1.3	3.4	4.4		4.4	0.2	0.1
Corn silage (347 samples)							
Average	34.9	8.5	73.9	6.3	74.2	0.2	0.2
Minimum	29.6	7.4	68.0		71.1	0.1	0.2
Maximum	40.1	9.6	79.8		77.2	0.2	0.3
Standard Deviation	5.3	1.1	5.9		3.1	0.1	0.0
Corn grain (55 samples)							
Average	72.0	9.0	45.4	4.1	87.7	0.0	0.3
Minimum	67.4	8.2	33.0		86.6	0.0	0.3
Maximum	76.7	9.8	57.8		88.7	0.1	0.3
Standard Deviation	4.6	0.8	12.4		1.1	0.0	0.0

[1]DM = dry matter; CP = crude protein; RDP = rumen degradable protein; TDN = total digestible nutrients; Ca = calcium; P = phosphorous.
[2]Medium frame steer, 600 lb, ADG = 1.5 lb
[4]1400 lb cow, moderate milk

The challenge is to decide what it is practical to test for. Nutrients of major concern include energy, protein, calcium and phosphorus. Vitamins and some of the trace elements are important, but will not be covered in this article. In deciding what to test for, the variability of the nutrient, the cost of analysis, and the cost of supplementation must be considered.

ENERGY

Energy is the nutrient required in the greatest amount and is determined for maintenance, growth and milk production. **I like to view energy as the gas pedal. More energy means more growth or more milk.** Energy values are not directly measured, but predicted by relationships using equations and relationships with other nutrients.

The primary source of energy is carbohydrates. Carbohydrates include sugar, starch, cellulose and hemicellulose. The cellulose and hemicellulose are contained in plant cell walls in a complex with lignin, an indigestible compound, while the sugars and starches are found in the cell contents. The cell walls are the lowest in digestibility, and cell contents highest. Thus, the higher the proportion of cell walls, the lower the energy value of the feed.

Total Digestible Nutrients (TDN). While not perfect, for most situations in the northeast TDN is the most common and easiest estimate of energy to use. In some labs, TDN represents the sum of digestible protein, digestible non-structural carbohydrates, digestible NDF and 2.25 x the digestible fat. In others it is a prediction formula using ADF.

The following laboratory procedures are used to estimate the usable energy content of a feed sample sent in for analysis.

1. Neutral detergent fiber (NDF). This is the moderately digestible fiber contained in the cell walls and is what gives the plant rigidity. For feeds high in protein, starch and/or ash, chemical procedures are used to remove these excess non-NDF nutrients and are listed as aNDF or aNDFom. Due to the partial indigestibility of cell walls, the higher the NDF, the less cattle can and will eat. Therefore growth and/or milk production goes down as the measure of NDF goes up.

2. Acid detergent fiber (ADF). A measure of the poorly digestible cell walls, primarily lignin. As ADF goes up the digestibility of the feed goes down which reduces the amount of energy available to the cattle. Again, less energy, less growth and/or milk production.

3. Fat. It is measured by ether extraction which solubilizes other nutrients and is therefore reported as Crude Fat. It has 2.25 times as much energy as carbohydrates and is a valuable nutrient. However, most locally produced feeds contain less than 5% fat. By-products such as distillers' grains and soybean meal are the exception and are high in fat.

PROTEIN

Crude protein (CP). This nutrient is determined by laboratory analysis measuring the nitrogen content of the feed. The nitrogen value is converted to crude protein by multiplying by 6.25. **If energy is analogous to a gas pedal, then I like to refer to CP as the oil in a car. Adding more oil will not make the car go faster, but if you don't have the minimum requirement, eventually the car won't go at all.** Protein is composed of amino acids. In ruminants a large supply of the protein requirement comes from the microbes in the rumen.

1. Degradable Protein (RDP) – consists of the soluble protein and proteins of intermediate ruminal degradability. The RDP is needed to meet the requirements for bacteria that

ferment the forage and grain in the rumen. These bacteria are then digested in the small intestine to supply bacterial (i.e., microbial) protein to meet the animal's requirements for maintenance and growth.

The amount of RDP is one difference between dry hay and baleage. The fermentation process makes the protein more readily available to the rumen bugs (more RDP and less RUP). For example, when baleage is the source of forage for growing cattle, the total CP of the diet will need to be higher as compared to when dry hay (at the same CP and energy) is provided.

2. Undegradable protein (RUP). This protein fraction is slow to degrade in the rumen and is passed into the small intestine for breakdown – also known as rumen escape or by-pass protein. The RUP supplements the microbial protein (RDP) in meeting the animal's requirement for maintenance and growth. Meeting both the RDP and RUP requirements are especially important for growing and finishing cattle.

3. Acid Detergent Insoluble Crude Protein (ADICP) – also known as heat damaged or unavailable protein. Heat damaged feeds will often appear dark brown or black. It is caused by heating during fermentation or drying. A portion of the protein reacts with carbohydrates to form an indigestible complex rendering it unavailable for digestion.

CALCIUM AND PHOSPHOROUS

Accurate methods are available for mineral analysis, and these are valuable as most rations need some supplemental minerals. The most important one, however, is the phosphorus content of silage and hay since it is the most expensive to supplement and most rations, particularly high forage rations, are deficient in phosphorus. However, many forages will be adequate in phosphorus, and less expensive supplementation programs can be developed. Calcium can be cheaply supplemented with calcium carbonate (ground limestone), and it is therefore of no great concern to obtain an analysis in order to save supplemental calcium.

Sampling Feeds for Analysis

Inaccurate sampling can lead to greater errors than using average feed composition tables. The sample must be representative of all the feed in question. The important factors to consider are when and how to sample feeds for analysis. In most states, your local county agent has sample bags and information on obtaining feed analysis. Also, most reputable feed companies will analyze your feed. There are also private laboratories that offer this service. After obtaining sample bags, the following guides can be used to obtain a representative sample.

1. Bunker silos or piles-Take 15 or more handfuls from all over the face of the silo after it is opened and you are into well packed, good quality silage. Mix the samples in a clean pail, then place about one quart in a plastic bag and either freeze it or send immediately for analysis. It is desirable to sample several times during the feeding period, particularly if there is any great variation in plant maturity, variety or soil type.

2. Dry Grain Sampling: Take a minimum of 5 grain samples, with a grain probe if possible from various places in the bin or truck. Mix them in a clean pail, then place about one pint in a plastic bag, seal and send in for analysis.

3. Hay Sampling: Take core samples from the end of a dozen or more bales taken from various places in the mow or stack. Mix samples together, then send in about one quart in a sealed plastic bag for analysis.

Whether you produce the majority of your own feed or purchase it, knowing the energy (fuel) and protein (oil) is critical to obtain the desired level of performance. Given the current low cattle prices, balancing a ration based on known values can keep you cost of production in line.

References

http://dairyone.com/general-resources/publications/

Fox, D. G. The Meaning and Use of Feed Analysis. The Cornell Beef Production Reference Manual. Fact Sheet 1101.